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ABSTRACT

This paper discusses computers and their potential role in education. The term "byte" is first explained, to emphasize the idea that the use of computers should be implemented one "byte" or step at a time. The reasons for this approach are then outlined. Potential applications in computer usage in educational administration are suggested, computer based instruction is described, and advantages and limitations of computer assisted instruction (CAI) systems are discussed. The remainder of the paper addresses the following questions: (1) How realistic are projections of computers with an artificial intelligence? (2) What are the best current uses of CAI systems? (3) What are other possible uses of the computer in institutional settings? (4) What are the benefits and possible curriculum implications for teaching students a computer language or programming? (5) What should be taught in a programming course and how should it be taught? and (6) What can computers do for people which they cannot now do for themselves? (LMM)

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ACCESSING COMPUTERS IN EDUCATION,

ONE BYTE AT A TIME

Anthony V. Manzo

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Accessing Computers in Education, One Byte at a Time

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Let us be clear about one thing from the outset, computers are no over-night sensation. Blaise Pascal built the first simple adding machine for his father, a customs officer in France, in 1642. Godfried Leibniz, in 1671, got the machine to multiply. And, it was two Americans, Hollerith and his assistant Powers who invented techniques for storing numerical data by means of holes punched in cards. These techniques were used in the 1890 census count. IBM and Remington Rand Corporation were on hand even then to perfect and develop the commerical potential of the punched card process.

So, it is only the extent of the role of computers in education which still is in a "discovery" stage. The question of whether computers should have a role is moot. They are here and they do.

I shall detail a representative set of facts regarding current and potential uses of computers, and their role potential in education, as near as I can deduce these at this time.

This information comes to you not from a 'computee', my name for a computer-oriented person, but rather as a report from a naive emissary just back from "Computer-ORK" where one encounters Bits and Bytes, CRT's and Floppy Disks. The assortment of such creatures evolving from this relatively new primordial soup seem to stir both excitement and fear. Both reactions are understandable and deserve some attention.

For those who have been following recent events, you know that it is not mere dramatics to refer to the study of computer technology as a visit to a parallel, but other world.

Within their core-culture, the inhabitants of this strange new world have created a relatively diverse culture, with over 200 different languages, a visually stimulating though otherwise sedentary system of amusement, and a different set of obsessions than most of us would be familiar with. Further, by several reports, one most recently from the aptly named news-journal called, Computerworld (8-81), they also have more than their share of emotionally strange people.

It may be, however, that it is their concentrated newness on the scene which causes them to appear strange. It has always seemed to me, for example, that many of us, such as math teachers and administrators, have some rather distinctive and unsettling characteristics. On some occasions, and by a quite precise definition of the term, I have even suspected that one could call English teachers a separate ethnic group. They, too, speak their own language, and follow their own obsessions.

Given the powerful magnetic draw of certain functions, or vocations, on human beings, it seems more, rather than less, proper to tell about this new tool with some accompanying editorial comment.

Before taking up my proposition that access, or use of computers, should be undertaken one byte at a time, permit a short lesson which can serve as a point of reference for this and related ideas.

What's in a Byte?

In computer jargon, a Byte is the smallest meaningful expression which can be made. It is comparable to a word, and typically, it is made up of 8 bits. Bits are the equivalent of conventional letters, though based upon a simpler binary code (+ -, or off-on, or 0-1). This has been found to be the most functional system for machine programming.

The coding, or load, capability of computer systems steps up quickly; thus while there are 8 bits to one byte, there are 512 bytes to 1 block, and 2 blocks to one K, or roughly a thousand bytes. K's are the most conventional method for expressing storage capability.

One K of storage capability is roughly equivalent to a conventional type written page (about 1,250 characters). The size of the storage capability of a computer, to some ways of thinking, is no longer as significant consideration as once it was thought to be.

This is due to the development of various forms of storage capability which can be attached to most any computer at very modest cost, and to advances in computer circuitry and programming. Through such "down-loading," as it is called, it has become possible to build reliable mini and micro computers. A mini, which is greater than a micro, though less than a system size, or maxi computer, stores upward of 500K bytes of information. A mini computer of this size could cost about $25,000. In contrast, a micro, or personal size computer, costs about $2,000, has approximately 16K bytes of basic storage capacity, and can be enhanced through tapes, and things called "Floppy Disks" to store about as much as the 25,000 dollar mini. As a rule of thumb, it costs about 9 cents per K byte to store information on tapes versus $100.00 per K byte for that same storage capacity to be built into the machine. This information comes to you from my personal mentor, Dr. Wayne Anderson of N.D.S.U.

Why One Byte At A Time?

The word Byte symbolizes, to me, the way in which computers should be accessed to education, that is, in one meaningful unit, or byte, at a time. I hasten to add, that we are picking this story up after it has been unfolding for some time. Therefore, there could be considerable justification for a particular institution to undertake as much as a 512 byte, or one Block access, as its very first bite.

There essentially are three classes of reasons to access computers in cautious steps. First, to permit whatever is bitten off, or accessed, to be ingested, metabolized, and evaluated. Secondly, because the dust hasn't settled yet on many issues bearing upon just what should be purchased or converted to computer processing. And, thirdly, due to personnel problems. Training programs are weak, and tend to frighten off all but the few who are naturally oriented toward computers; and they, remember, are an unusual lot.

Computer companies would urge us to buy large systems in anticipation of expanded use. Ironically, it is mathematicians, our apparently logical consultants on such matters, who tend to urge us to buy smaller computers with less storage.

In fact, both parties have a point, depending upon priorities and such. The mathematician, for example, tends to employ computers mainly as an incidental, adjunct aid to research in mathematics. A typical use would be to employ an algorithm, or controlled recurring function, to conduct a set of operations to solve for an equation, where the problem and method of resolution are well understood, but the computation is too tedious to be undertaken easily. In contrast to such "number crunching," administrators, publishers, law firms and such tend to rely heavily upon the computers for the storage and processing of language characters, and very little upon its ability to manipulate data.

In fact, by recent accounting over 99% of current computer use is in language storage and retrieval, and less than one percent in "number crunching".

From this point, I shall address more explicitly to current and potential uses of computers in education, including educational administration, research, instruction and curriculum.

Computer Uses in Educational Administration

Two seemingly reasonable uses of computers have not yet firmly taken hold in educational administration. One is to speed registration for classes, which seems as if it could be done in much the same way that one books passage on an airplane. A student should be able to call in and register for classes at any time after the schedule is posted, and then, perhaps by mail or by personal pick-up, to receive a confirmation along with an "admit" card, seat number, and a bill. The computer could be programmed to cancel this registration automatically if the bill is not paid by a given date.

Secondly, the huge volumes of information collected upon students ought to be

prepared and stored in more accessible ways so that it could be "farmed" more intelligently for institutional self-study and appraisal, (such as providing better service to students), and for a range of potentially valuable research purposes. The research thrust could be planned in response to proposals from faculty, or other research based groups, and conducted within normal guidelines governing protection of privacy and other undue infringements.

The use of such data by administrators could provide much of the bases for decisions regarding the use of the computer in instruction, our next focus.

Computer Based Instruction

Computer usage in teaching can be categorically summarized under the label Computer Assisted Instruction (CAI). While some would resent this all inclusive category as not representing the "uniqueness" of their particular program, all would agree that even an approach which is different would have to be defined in terms of how it deviates from the CAI format.

The most extensive library of pre-packaged programs in CAI are in the Plato system, located at the University of Illinois at Urbana, and now commercially available through Control Data Corporation.

All that is required to access this program is a Plato terminal, which is relatively inexpensive, and a contract with Control Data or the university to enter their system through phone hook-up.

As early as 1975 this system contained programs from elementary thru professional school levels, in subjects varying from the vocational, such as food service training to aeronautical and astronautical engineering.

These programs, while stored in Illinois, are the work of many subcontractors around the nation. Most of the funding for these and other CAI programs and related research was from the National Science Foundation, the U.S. Army, the Navy Department.

Advantages and Limitations

Upon learning of alternate means for doing anything, the wise educator asks "What are the likely advantages and drawbacks to the alternate approach over the present system?", and, too, while it is not strictly speaking, an instructional consideration, the question of cost-effectiveness must be raised in order to assess the practicability of the proposed venture.

The most significant advantage of the "interactive computer," or CAI systems, also constitutes its greatest drawback: it is a teaching machine which tends to replace the teacher. As such, there is no teacher personality to complicate and crimp the student, nor, however, is there a teacher to stimulate the student, or to offer the powerful integrating value of a role model.

Evidently, then, CAI is a relatively specialized tool, which as with all things specialized, has considerable appeal to some, though not to others, and considerable appropriateness in some situations, but not in others.

The chief benefits of CAI based teaching-learning are found in the context which nourished it; namely, in meeting the technical training needs of the armed services. By remote satellite, any course of study can be beamed to a waiting serviceman (or woman), any place on the face of the earth, including a ship at sea.

In other words, a library able to teach about itself can be made accessible any where a terminal can be installed. The potential impact of this point alone seems to justify access to the Plato system by every educational facility. The presence of such a system places a voc-tech teacher, a physicist and a hundred other specialist at the disposal of any interested student no matter how impoverished is the rest of the educational situation.

Add to this the fact that most of these programs were designed, constructed and evaluated by teams of some of the best learning and content specialist available,

and justification seems to be complete for a 512 Byte, or 1 Block, access to at least this computer assisted instructional network.

Given this rather large Byte, many nagging questions and issues remain. In an effort to deal with this array, albeit in a cursory manner, I have organized the remainer of this paper into a question and answer format, a sort of, "Everything you wanted to know about computers and education, but didn't quite know how to ask..."

*How realistic are projections of computers with an "artificial" intelligence able to rival the human mind?

This is possible though not plausible with current or future technology. The computer cannot reflect upon itself, nor can it create metaphors, and therefore see similarities in seemingly dissimilar things; unless, of course, it is programmed to do so...in which case it would do so, and then await a new command telling it what it might do with such information.

Comparisons drawn between computers and the human brain are inevitable, but the two are not analogous. While computers have an almost infinite capacity for storage and recall, the human mind can only hold about 100 bits of unrelated information in short-term storage. On the other side, the best computers now available cannot duplicate the ability of the brain to carry out, such simple split second visual operations as make it possible to easily tell one person from another. The fact is, the best computer in the world, costing about $12 million dollars, can only handle 1 trillion bits of information per second, while the most feeble of human minds is estimated to be able to handle about 10 trillion bits per second (Psychology Today, June 1981, p 108).

*What are the best current uses of Computer Assisted Instructional Systems?

This seems most apparent: 1. curriculum enhancement - by virtue of the programs which can be accessed which otherwise would not be available in a given locale; 2, corrective and remedial type work - by virtue of the computer's tireless

ability to repeat things, loop to simpler programs, and, most importantly, increase a student's actual"time-on-a-task"(the computer, remember, doesn't need much rest, and can be available whenever the student "comes around" as it were); and, 3. for "shut-in" - portable models can be connected by phone to a central system, thus reducing the number of visits required by the itinerant teacher and permitting the student to work at his/her own pace.

What are other possible uses of the computer in instructional settings?

There are many. Categorically these are called Computer Managed Instruction (CMI).

Most CMI ventures, however, have focused upon the computer as an expensive student record storage system. I have a somewhat different vision.

I foresee a time when teachers will purchase a portable, rolling system which I would call a 'Teaching Assistant.' It would be equipped to assist the teacher in a wide array of ways. The TA would be able to generate, score and interpret tests. It would be able to recommend instructional materials and approaches. It would provide specific step-by-step visual prompts to the teacher on sophisticated teaching procedures, as well as other such assistance as emergency information in case of fire or disaster, and perhaps, even, some reminders as to how to defuse a tense situation in class.

I see these TA's as able to be enhanced by a wide variety of taped programs and lessons, developed commercially and/or by teachers, and by the addition of other parts and devices suiting each teachers special interest and needs. Three obvious examples of such devices would be an auditory recording capability, a visual projection device, and a modest voice amplification system for those days where the voice is weak and the noise level high; as from students passing, lawn mowers, outdoor recess, and other such incidental but frequent distractions.

I envision, I might add, that these TA's, while they would cost a good deal to purchase, would have several benefits. Initial costs could be brought into

balance by benefits which most other professionals already enjoy. Under current IRS rulings, for example, such "hardware" probably would qualify for tax credit, while the "soft-ware" - or notes, lessons, and programs which teachers would store in them over the years, could accure considerable value, and likely could be resold upon retirement, if not before through duplication.

I feel certain that low, or no, interest loans, or even partial payment arrangements, could be negotiated with school districts, or other employers.

I would resist having districts own these, however, because they should remain as private and personal as a master carpenter's tools.

*What are the benefits and possible curriculum implications for teaching students a computer language, that is, how to program computers, as well as merely work with CAI programs?

A long answer to this question would be too long, too dense, and too ambivalent in its conclusions, and probably still not be very satisfying. In the interest, however, of thoroughness in treating the more critical computer related issues confronting educators, please permit a brief synopsis of certain facts and factors which I believe are central to whatever conclusions individual educators eventually reach on this matter.

1. It is said that learning a computer language enhances logical thinking processes. This should sound familiar. It was this same rationale, more or less, which prompted the inclusion and then, the stress upon grammar, algebra, geometry, foreign language and Old English in the curriculum of a prior generation. The benefits of such to thinking skills, particularily to "transfer of training," the presumed purpose of studying abstract functions, never was documented, and eventually led to the total abandonment, of such courses of study. Now, once again, we are trying to find a reasonably proportional place for these, but anyone who has suffered through these, likely will need a good deal of convincing before they would subject their children to that painful, and seemingly, infertile experience.

So, then, let us be cautious of not accepting unsubstantiated claims regarding

the "mental development" values of studying computer language.

2. Another thing to keep in mind when considering offering a course in computer programming is the fact that it is very, very difficult to learn any language to a practical level. A computer programmer is a master mechanic, usually specializing in not more than one or two languages, and rarely more than one or two applications of these languages; and, still, she/he does not expect to write a successful program without spending hours, if not days, in "debugging". It simply is folly to believe that anyone can be taught casually, or incidentally, to write programs. The Plato system, as example, was designed to allow teachers to do this, and it has totally failed in this regard.

Personal size computers and the books and CAI programs available to teach a person to use these are little more than parlor amusements which, fortunately, do rival T.V. re-runs. As such, they should not be discouraged, but, too, we shouldn't expect any more to come of such efforts than would accure from learning to play chess or bridge.

3. Assuming that a decision is made to teach a course in the computer, what should be taught and how should it be taught?

The course, first of all, should be optional, though a unit of study on advances in computer technology probably should be a required part of the social studies and science curricula.

What should be taught can best be summarized by the term "conversance," or medium-depth-familiarity. This, would include information such as presented today, and, not meaning to contradict myself, but also a fair sampling of a computer language, such as BASIC or PASCAL. These are the simplicit and most widely used languages today; although, a language called APL is far superior, in my opinion.

How these things should be taught is a question which should be answered by a round of research into the most effective methods.

Currently computer languages tend to be taught in a relatively straight forward way resembling in format, style, and assignments the ways in which mathematics is taught. Needless-to-say, these methods are very discriminatory. About 15% of each group so taught seem to learn while the rest burn precious life energies consumed, to a greater or lesser degree, by self-doubts, anxiety attacks, frustration, distraction from other studies, and all with no apparent benefit.

There probably is no easy alternative to current methods, but I believe that there are some which deserve to be tried carefully. One would be to teach computer language by the theories of learning which are collected under the name "Reading in the Content Areas". Specifically, I would apply the particular set of such rules outlined by Sherk and myself and called the LICA, or 'Languaging in the Content Areas' design.

By the LICA precepts, students would not be obliged to write computer programs until several steps and conditions were met which, in large measure, are deduced from how language and thought are first learned and enriched.

In short, the approach would be first to teach students how to listen and to talk and therefore be able to ask questions in computer-like language. Then, would they be taught to read, or trace, computer selected programs. Then, more or less concurrent with this step, would they observe the teacher, presumably a skilled programmer, attempting to create and debug (or correct) programs. And, finally, would they become responsible for attempting to write programs themselves.

For this general scheme to work well, there probably would need to be certain slight deviations from it and conditional events developed with in it. Specifically, students, obviously, would need to be taught directly and immediately how to "log on" and off the machine and to read, write and run very, very simple programs. They also would need to be led to either create or select an appropriate, and personally fulfilling program which they would wish to complete as a long term project. (The

project would not need to be limited by the time or scope of the course.)

One additional consideration comes to mind, which has considerable implications for the entire school curriculum; clearly, everyone will need to be taught to type, as early on as possible. Say, in first grade (?).

*In summary, then, this question could be raised regarding computers and education: what can computers do for us which we cannot now do for ourselves?

The answer to this simply is, not much! We can live well without them, but there is no doubt that we can do much better with them.

The computer, after all is a modern age instrument, somewhat like a violin. The option to use it converts a band into an orchestra.

Computers, in my opinion, can be intensely humanizing, rather than dehumanizing. It will depend upon the parts written for them and who plays them. If you have ever heard music written by Johann Strauss and the violin played by Itzok Perlmen you'll know we have little to fear and much to look forward to.

Thank you.